two ways: First, a granite reef crosses from Kangaroo Island to the mainland, at a place 10 miles north of Kingston jetty. It is marked on the chart "Nation Reef" and "Granite Rocks." I have never known a thunderstorm from the northward to cross this reef. It invariably follows it into the interior. The rains may come on here, in part, but the storm follows the reef. A gale was reported to me by the head keeper, Cape Jaffa Lighthouse, 11 miles south of this place, as having been the heaviest he had known during twenty years duty there. The sea broke over the lantern, which is 120 feet above the sea level. During that day there were 8 fishing boats out from here, small centerboard luggers, with two men in each boat. They fished about 6 miles out and for want of wind had to pull home. The wind and sea were dead calm in Lacepede Bay; the gale went over our heads and descended about 10 miles inland, doing considerable damage. I have seen many similar instances, and have never heard them accounted for, as there is nothing to give us a lee. In ordinary weather the bay is full of cross currents of wind and sea.

* * * * * * *

Whatever may be the nature of the influence that generally prevents outside gales from blowing their proper course through the bay, it is intermittent, as gales occasionally blow home with undiminished force.

Mr. James Page of the United States Hydrographic Office adds the following note.—Ed.:

Kingston (Port Caroline) is situated in Lacepede Bay on the south coast of Australia; latitude 36° 50′ 16″ south; longitude 139° 50′ 56″ east. Robe is on the coast 20 miles to the southward. Concerning Lacepede Bay the Australia Directory, Volume I, p. 361, states as follows:

"It is a remarkable fact that this bay, although apparently exposed to the ocean swell, affords safe anchorage in all weather, there being tolerably smooth water even on the highway of a westerly gale. Two reasons account for the smoothness of the water—the force of the prevailing swell from the southwest is broken by the reefs off Cape Jaffa, and that from the northwest and west by traversing, before it arrives near the anchorage, a long extent of undulating ground with shallow water over it, there being only 20 fathoms 16 miles west of Kingston jetty."

JANUARY GALES FROM THE GREAT LAKES TO THE MARITIME PROVINCES.

By B. C. WEBBER, Forecast Official and Inspector to the Meteorological Service of Canada, dated February 19, 1902.

In treating of the storms which have been experienced in Canada from the Great Lakes to the Maritime Provinces in January from the years 1874 to 1902, inclusive, the writer does not intend to enter to any extent into the question of the why and wherefore of the development of these storms, or to discuss whether or no the course of storms is governed by the anticyclones or the many other vexed questions upon the subject which have been from time to time considered. Having gained considerable assistance himself in forecasting, by the tabulation and study of the storms of the different months of the year, he may possibly be able to point out a few salient features which may be available to others in scientific weather forecasting. As a review of the twelve separate months would necessarily occupy a large amount of space, the month of January only will at present be considered. In the first place perhaps it will be as well to give a table of the number of low areas charted, the percentage of storms caused by them, and the percentage of storms caused by lows from the several directions.

In explanation it should be stated that northwest lows are those originating or moving from the region between the British Columbia coast and Manitoba; west lows, those from the Pacific coast and Western States between latitudes 48° and 35°; southwest lows, from lower California, Mexico, Texas, and the Gulf of Mexico; Atlantic lows, as designated; erratic lows, developing anywhere from the lakes east to the Maritime Provinces including the New England States.

TABLE 1.—*Number of lows and the direction from which they came.*

Total number.	Northwest.	West.	Southwest.	Atlantic.	Erratic.
330	129	61	87	24	9

TABLE 2.—*Percentage of low areas causing gales; also percentage of gales from areas moving from the several directions.*

District.	Total No. of gales.	Total per cent of areas causing gales.	Per cent from northwest.	Per cent from west.	Per cent from southwest.	Per cent from Atlantic.
Lakes	162	49.9	45.0	64.0	54.0	0.0
Lower St. Lawrence and Gulf.	167	50.6	32.2	49.2	65.5	50.0
Maritime Provinces	176	53.3	29.5	50.8	78.2	75.9

In referring to Tables 1 and 2 we are at first impressed with the few erratic lows or abnormal developments, yet on second reflection we realize that were such conditions of frequent occurrence the efficiency reached to-day in scientific weather forecasting could not have been obtained; consequently we learn that normal movements are to be expected, not abnormal or highly improbable, as we are at times apt to endeavor to persuade ourselves is to be the case.

The percentage of gales caused by northwest lows diminishes rapidly as we proceed eastward; this is instructive, showing as it does that a considerable number of this class of areas decrease in energy as they progress toward the Atlantic. The same conditions hold good as regards the west lows, but to a lesser extent; a much larger percentage of west than of northwest lows cause storms however. This may in a measure be accounted for by the frequency with which in this class of areas the secondary developments occur, without which the primary system does not as a rule long retain its energy. Referring to the southwest lows we find the conditions practically reversed, for the percentage of gales caused by these areas increases rapidly as the eastern portion of the continent is reached. This knowledge is again useful, indicating as it does that a considerable number of these important disturbances do not affect the Lake region to any extent. When we come to the Atlantic series of areas, or those disturbances which either pass up toward the Maritime Provinces from the United States Atlantic coast or from far out to sea, it is seen that in the long period herein considered none of these areas gave a storm in the Lake region; and further, that a large number moved so far to the southward of Nova Scotia that their influence did not extend as far to the northward as the Gulf of St. Lawrence, suggesting that the gales caused by them are more likely to be backing than veering.

The gales of January have been separated into three classes: those of great violence, the fresh gales, and the moderate storms. Combining the first two classes, the percentage of the fresh to heavy gales for the districts is as follows: lower lakes, 46.3 per cent; lower St. Lawrence and Gulf, 65.9; Maritime Provinces, 53.4. Therefore fresh to heavy gales are more numerous in the Maritime Provinces than in the Lake region, and still more frequent in the lower St. Lawrence and Gulf. In the Lake region the gales of a marked heavy type were 25, or less than 1 for each January. In the lower St. Lawrence Valley and the Gulf the maximum was reached with 68, while in the Maritime Provinces there were 54.

The question naturally arises, what is the cause of these violent gales? Can any reasons be given for their development, and are there any guides to aid in anticipating these great atmospheric disturbances? In the first place the violent

TABLE 1.—*Mean maximum, minimum, and range of temperature at the Weather Bureau and Forest Park observatories, St. Louis, Mo.*

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.		Five-year averages.	
	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.
Maximum.....	42.8	41.9	43.9	43.8	45.9	44.8	67.4	66.7	72.8	72.1	84.1	82.7	83.8	82.3	83.4	82.8	84.3	84.3	67.2	67.3	47.8	47.8	50.8	50.8	64.1	63.5
Minimum.....	30.5	28.0	27.9	25.0	32.0	30.4	50.0	45.6	54.3	48.8	67.3	63.6	66.0	60.5	66.2	61.4	63.8	54.8	47.9	42.1	35.1	32.9	34.7	33.2	47.5	42.9
Range.....	12.3	13.9	16.0	18.8	13.9	14.4	17.4	21.1	18.5	23.3	16.8	19.1	17.8	21.8	17.2	21.4	20.5	29.5	19.3	25.2	12.7	14.9	16.1	17.6	16.6	20.6
Diff. in min., W. B.—F. P..	2.5		2.9		1.6		4.4		5.5		3.7		5.5		4.8		9.0		5.8		2.2		1.5		4.6	

gales caused by northwest lows are few in number, and they appear to be of three types: The low which steadily increases in energy as it drifts eastward; the low immediately succeeded by a great cold wave; and the low which at first travels far southeastward, and then suddenly recurves northeastward. The violent gales from west lows are even fewer than those from the northwest; but a suggestion has already been hinted at elsewhere in this paper regarding this class of areas. The southwest low so frequently shows such energy from its apparent inception that no doubt exists as to its ultimate destructive character; but if in a seemingly weak area two or more foci appear, or should there be a secondary development in the southern part of the system, or on or near the United States Atlantic coast, usually in the vicinity of New Jersey or Connecticut, then a storm of great violence almost invariably ensues. There are not many Atlantic lows, as will be seen by referring to the table; nearly all, however, bring a gale to the Maritime Provinces, although the violent gales caused by them are few in number, doubtless owing to their general course being far to the southward of Nova Scotia.

The erratic developments herein considered must not be confounded with the erratic change of the course of a low from the normal to the abnormal, which from time to time is observed. These apparent peculiar or backward movements of depressions are so rare that they hardly enter into the consideration; however, it would be very interesting to have the opinion of others on the causes of these sporadic movements, especially as there are instances on record where, owing to such conditions, the gale which had seemingly subsided has again set in with greater violence than before.

ABSTRACT OF A COMPARISON OF THE MINIMUM TEMPERATURES RECORDED AT THE UNITED STATES WEATHER BUREAU AND THE FOREST PARK METEOROLOGICAL OBSERVATORIES, ST. LOUIS, MO., FOR THE YEAR 1891.[1]

By W. H. HAMMON and F. W. DUENCKEL.

Forest Park, St. Louis, Mo., is a tract of ground about 1 mile wide from north to south and 2 miles long from east to west, its eastern boundary being about 4 miles west of the Mississippi River. About midway between the park and the river, at Thirty-sixth street, is a slight elevation, and east of this, in Mill Creek Valley and along the banks of the Mississippi, the principal manufactories are located.

The principal railroads from the west enter the city by way of the valley of the River des Pères and Mill Creek Valley. Along these railroads are several manufactories, but the nearest of any importance is 1½ miles south of the southeast corner of the park.

From this it seems that the park is quite well removed from the smoke and other conditions peculiar to large cities, except when east winds, which are infrequent, prevail.

The observatory is located on a slight knoll about half a mile from the east end of the park and midway between the northern and southern boundaries. About 100 yards to the north and 30 feet lower than the observatory is a valley through which flows a small stream, while to the southwest is quite a heavy forest growth extending back from the observatory to the top of a slight ridge. In other directions are open lawns interspersed with small groves of trees.

The thermometer shelter, which is of the Weather Bureau pattern, is located about 96 feet east of the observatory building, 10 feet above the sod, and 75 feet from the nearest trees.

The anemometer is exposed 8 feet above the roof of the observatory and 58 feet above ground. It is on a general level with the tops of surrounding trees.

The observatory of the United States Weather Bureau is located in the Government building at Eighth and Olive streets, a little more than half a mile from the river. It is surrounded on all sides by chimneys belching forth smoke from bituminous coal, which is almost the exclusive fuel of the city. The building covers an entire block 300 feet square, and is arranged about a court which is open to the lower floor.

The thermometer shelter is located 10 feet above the copper roof of this building, and 110 feet above the level of the street.

On the center of the south front of the building is a tower 200 feet high, on the top of which the anemometer is exposed far above the tops of surrounding structures.

Table 1 shows the monthly means of the daily maximum, minimum, and range of temperature during the year 1891, at both the Weather Bureau and the Forest Park stations. It also shows the differences between the monthly mean minimum temperatures at the two stations, and the annual averages for the above data for the five years 1891–1895, inclusive.

The noteworthy feature of this table is the difference in the monthly mean minimum temperatures at the two stations, the Forest Park minimums averaging from 9.0° lower in September to 1.5° lower in December. The extreme differences have ranged from 20° lower to 2° higher.

In order to study these remarkable differences, tables were prepared in which were entered the minimum temperature recorded at 8 a. m., the cloudiness at 8. a. m. and the previous 8 p. m., and the average wind velocity during the night. Curves were also drawn showing the relation between the cloudiness, the velocity of the wind, and the minimum temperature differences at the two stations. In general it was found that as the cloudiness increased the wind velocity also increased, and the differences between the minimum temperatures decreased. It was also found that both the cloudiness and the velocity of the wind exerted an influence upon the minimum temperature differences.

In the study of these observations it was found that during the clear skies of September the maximum differences were recorded, while during the cloudiest months (March and December), the differences were least, and that they remained small during all the winter months. There were, however, marked exceptions to this rule, as for instance in January, 1892, when the difference exceeded 20° on three successive days. During this period there was a heavy covering of snow on the ground at the park and for a portion of the time there was a little snow in the city, but it was soon covered with soot and quickly disappeared.

A special study was made of the minimum temperature differences on all the days when snow was on the ground at the

[1] Compiled by W. H. Hammon, Forecast Official United States Weather Bureau, and F. W. Duenckel, of the Forest Park Meteorological Observatory; read before the St. Louis Academy of Science, March 2, 1896, and now first published.